A Student's Guide to the Mathematics of Astronomy

The study of astronomy offers an unlimited opportunity for us to gain a deeper understanding of our planet, the Solar System, the Milky Way galaxy, and the known Universe.

Using the plain-language approach that has proven highly popular in Fleisch's other *Student's Guides*, this book is ideal for non-science majors taking introductory astronomy courses. The authors address topics that students find most troublesome, on subjects ranging from stars and light to gravity and black holes. Dozens of fully worked examples and over 150 exercises and homework problems help readers get to grips with the concepts presented in each chapter.

An accompanying website, available at www.cambridge.org/9781107610217, features a host of supporting materials, including interactive solutions for every exercise and problem in the text and a series of video podcasts in which the authors explain the important concepts of every section of the book.

DANIEL FLEISCH is a Professor in the Department of Physics at Wittenberg University, Ohio, where he specializes in electromagnetics and space physics. He is the author of *A Student's Guide to Maxwell's Equations* and *A Student's Guide to Vectors and Tensors* (Cambridge University Press 2008 and 2011, respectively).

JULIA KREGENOW is a Lecturer in Astronomy at the Pennsylvania State University, where she is involved in researching how to more effectively teach science to non-science majors.

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Daniel Fleisch
Wittenberg University

Julia Kregenow
Pennsylvania State University

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Contents

Preface

This book has one purpose: to help you understand and apply the mathematics used in college-level astronomy. The authors have instructed several thousand students in introductory astronomy courses at large and small universities, and in our experience a common response to the question "How's the course going for you?" is "I'm doing fine with the concepts, but I'm struggling with the math." If you're a student in that situation, or if you're a life-long learner who'd like to be able to delve more deeply into the many wonderful astronomy books and articles in bookstores and on-line, this book is here to help.

We want to be clear that this book is not intended to be your first exposure to astronomy, and it is not a comprehensive treatment of the many topics you can find in traditional astronomy textbooks. Instead, it provides a detailed treatment of selected topics that our students have found to be mathematically challenging. We have endeavored to provide just enough context for those topics to help foster deeper understanding, to explain the meaning of important mathematical relationships, and most of all to provide lots of illustrative examples.

We've also tried to design this book in a way that supports its use as a supplemental text. You'll notice that the format is modular, so you can go right to the topic of interest. If you're solid on gravity but uncertain of how to use the radiation laws, you can skip Chapter 2 and dive right into Section 3.2 of Chapter 3. Additionally, we've put a detailed discussion of four foundational topics right up front in Chapter 1, so you can work through those if you're in need of some review on unit conversions, using ratios, rate problems, or scientific notation.

To help you use this book actively (rather than just passively reading the words), we've put one or more exercises at the end of most subsections. These exercises are usually drills of a single concept or mathematical operation just discussed, and you'll find a full solution to every exercise on the book's

website. Additionally, at the end of each chapter you'll find approximately 10 problems. These chapter-end problems are generally more comprehensive and challenging than the exercises, often requiring you to synthesize multiple concepts and techniques to find the solution. Full solutions for all problems are available on the book's website, and those solutions are interactive. That means you'll be able to view the entire solution straightaway, or you can request a hint to help you get started. Then, as you work through the problem, if you get stuck you can ask for additional hints (one at a time) until you finally reach the full solution.

Another resource on the book's website is a series of video podcasts in which we work through each section of the book, discussing important concepts and techniques and providing additional explanations of equations and graphs. In keeping with the modular nature of the book, we've made these podcasts as stand-alone as possible, so you can watch them all in order, or you can skip around and watch only those podcasts on the topics with which you need help.

The book's website also provides links to helpful resources for topics such as the nature of light, the center of mass, conic sections, potential energy, and significant figures (so you'll know when you should keep lots of decimal places and when it's safe to round your results).

So if you're interested in astronomy and have found mathematics to be a barrier to your learning, we're here to help. We hope this book and the supporting materials will help you turn that barrier into a stepping stool to reach a higher level of understanding. Whether you're a college student seeking additional help with the mathematics of your astronomy course or a life-long learner working on your own, we commend your initiative.

Acknowledgements

This book grew out of conversations and help sessions with many astronomy students over the years. The initiative of those students in asking thoughtful questions, often in the face of deep-seated math anxiety, inspired us not only to write this book, but to make every explanation as clear and complete as possible. In addition to inspiration, our students have provided detailed feedback as to which topics are most troublesome and which explanations are most helpful, and those are the topics and explanations that appear in this book. For this inspiration and guidance, we thank our students.

Julia also thanks Jason Wright for his moral support throughout the project and for sharing his technical expertise on stars, and she thanks Mel Zernow for his helpful comments on an early draft.

Dan thanks Gracie Winzeler for proving that every math problem can be overcome by persistence and determination. And as always, Dan cannot find the words to properly express his gratitude to the galactically terrific Jill Gianola.